MOTION AND FINITE ELEMENT ANALYSIS OF FIVE FINGERED ROBOT GRIPPER

T.MOUNIKA, RAJU AMBATI, PRABHAKAR DAPPU

4.O.SAMBARAJU, 5.M.RAMA KOTAIAH

Assistant professor, Department of Mechanical Engineering, Ellenki College of Engineering and Technology, Hyd, 502319.

E mail id: t.mounika32@gmail.com

Abstract:

A robot gripper is that the physical realization of a mechanical device system to perform physical handling tasks mechanically. A robot griper is a vital component of the robotic system and it's designed to suit industrial application to generally grasp, carry, manipulate and assemble the elements. The planning of a gripper finger could be a troublesome task with several issues like task needs, geometry of gripper and also the complexness of mechanism.

In this project, a five fingered robot gripper is designed and modelled in 3D modelling software Solid works. Motion analysis is performed on the gripper by applying angular displacement to the rotary motors determine angular velocity, angular momentum and motor torque.

Static analysis is performed on the robot arm by applying forces of 50 Kgf, 100 Kgf and 150 Kgf using two different materials Alloy Steel and Carbon Fiber to determine stresses and displacements on the robot gripper. Motion and Finite Element analysis is performed in Solid works.

Keywords: gripper, manipulator, grasping, vonmises stress, carbon fiber, motor torque.

I.INTRODUCTION

A gripper could be a device that allows the holding of an object to be manipulated. The better way to describe a gripper is to think about the human hand. Similar to a hand, a gripper allows holding, tightening, handling and releasing an object.

The manipulator consists of segments that will be articulate which move regarding, permitting the robot to try and do work. The manipulator is that the arm of the robot that should move materials, parts, tools, or special devices through numerous motions to produce helpful work.

A manipulator may be known by methodology of management, power supply, effort of the joints, and different factors. These factors facilitate establish the most effective style of robot for the task at hand.

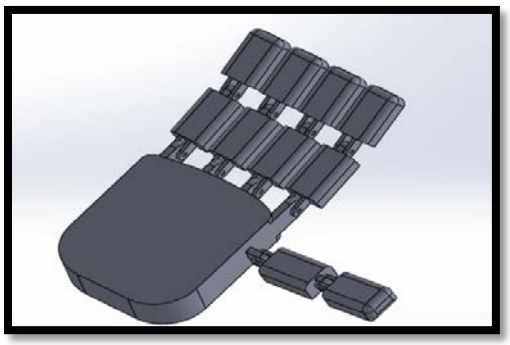
II. 3D MODEL OF 5 FINGERED ROBOT GRIPPER ARM

III.MOTION ANALYSIS

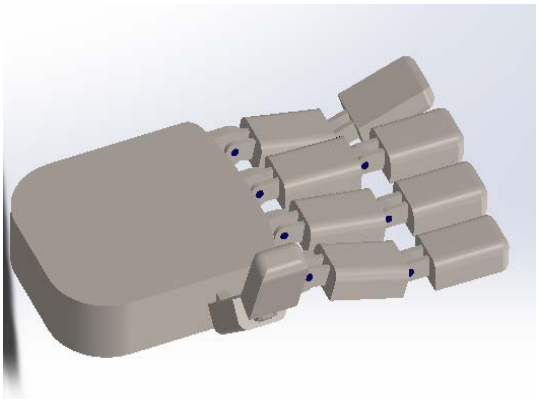
The Motion Analysis Is Conducted By Applying The Angular Motion To The Fingers. Fixed and moving components in SolidWorks Motion are determined by their Fix/Float status in the SolidWorks model. In our case, Bottom component is fixed while the five fingers are moving.

Motion Analysis is used to run computationally robust simulations that take the physics of the assembly motion into consideration.

By applying simulation to the 3d model of 5 fingered robot gripper we get the simulation model.



Simulation model



IV.STATIC ANALYSIS

Static analysis is performed on the robot arm by applying forces of 50Kgf, 100Kgf and 150Kgf using two different materials Alloy Steel and Carbon Fiber.

MATERIAL - ALLOY STEEL

By considering the alloy steel material,
Alloy steel material properties:

MATERIAL – CARBON FIBER:

Carbon fiber Material Properties:

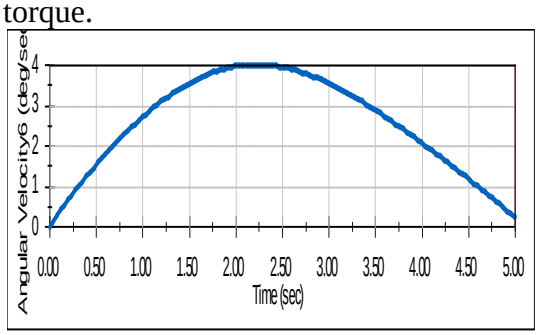
Name:	Carbon Fiber
Model type:	Linear Elastic Isotropic
Default failure criterion:	Max von Mises Stress
Yield strength:	4.15e+009 N/m^2
Tensile strength:	3e+007 N/m^2
Elastic modulus:	2.31e+011 N/m^2
Poisson's ratio:	0.394
Mass density:	1780 kg/m^3
Shear modulus:	3.189e+008 N/m^2

Property	Value	Units
Elastic modulus	21000	N/mm^2
Poisson's ratio	0.28	N/A
Shear modulus	79000	N/mm^2
Mass density	7700	Kg/m^3
Tensile strength	723.8256	N/mm^2
Compressive strength	-	N/mm^2
Yield strength	620.422	N/mm^2
Thermal expansion coefficient	1.3e-005	/K

V. RESULTS AND DISCUSSIONS

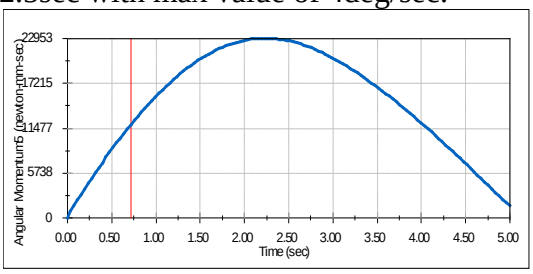
MOTION ANALYSIS:

Motion analysis is performed on the gripper by applying angular displacement 45 degrees to the rotary motors to determine angular velocity, angular momentum and motor torque.



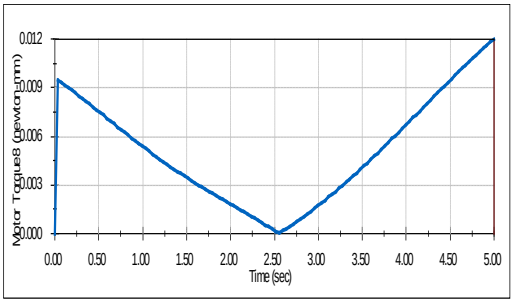
Angular Velocity at Motor joint

The maximum angular velocity is obtained at 2.5sec with max value of 4deg/sec.



Angular Momentum

The maximum angular momentum is obtained at 2.5sec with max value of 22953 N mm sec.



Motor Torque

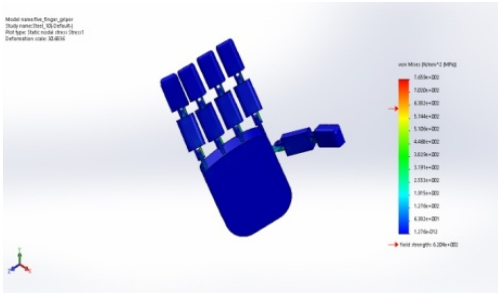
The max torque of the motor is obtained at 5 secs with value of 0.012 Nmm.

STATIC ANALYSIS:

Static analysis is performed on the robot arm by applying forces of 50Kgf, 100Kgf and 150Kgf using two different materials Alloy Steel and Carbon Fiber.

MATERIAL – ALLOY STEEL

Name	Type	Min	Max
Stress1	VON: von Mises Stress	1.91434e-012 N/mm^2 (Mpa) Node: 42088	1148.8 N/mm^2 (Mpa) Node: 11849

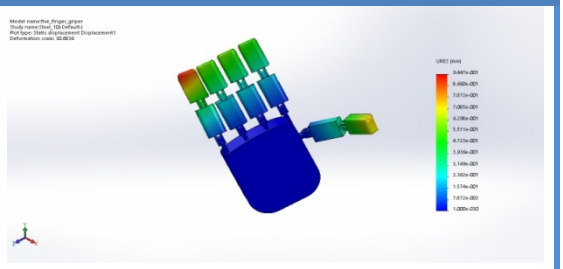


five_finger_griper-Steel_150-Stress-Stress1

Vonmises stress

Maximum vonmises stress is obtained by applying 150 kgf with the value of 1148.8N/mm^2.

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 36287	1.41701 mm Node: 33738

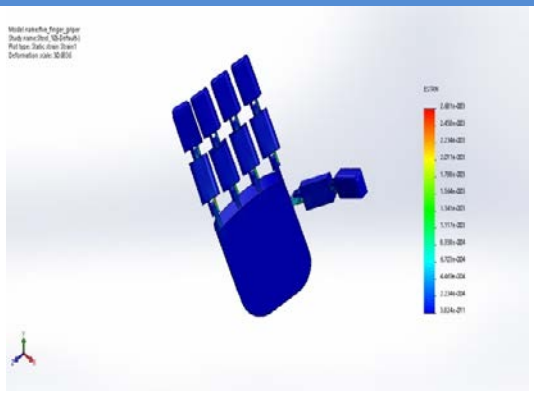


five_finger_griper-Steel_150-Displacement-Displacement1

Resultant Displacement

Maximum resultant displacement is obtained by applying 150 kgf with the value of 1.41701mm.

Name	Type	Min	Max
Strain 1	ESTRN: Equivalent Strain	5.73606e-011 Element: 33137	0.00402205 Element: 8211



five_finger_griper-Steel_150-Strain-Strain1

Equivalent strain

Maximum equivalent strain is obtained by applying 150 kgf with the value of 0.00402205.

MATERIAL – CARBON FIBER

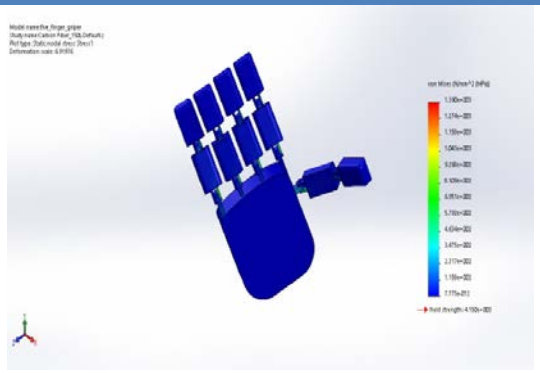
FORCE – 150Kgf (1471.5N):

Name	Type	Min	Max
Stress1	VON: von Mises Stress	7.77549e-012 N/mm^2 (MPa) Node: 42088	1390.13 N/mm^2 (MPa) Node: 12469

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-4, ISSUE-2, 2017
DOI: 10.21276/ijcesr.2017.4.2.7

Materials	Force (Kgf)	Stress (N/mm^2)	Displacement (mm)	Strain
Alloy steel	50	382.93	0.472338	0.00134068
	100	765.866	0.944676	0.00268137
	150	1148.8	1.41701	0.00402205
Carbon Fiber	50	463.377	1.14256	0.00129156
	100	926.753	2.28513	0.00258313
	150	1390.13	3.42769	0.0038746

Name	Type	Min	Max



five_fingered_gripper-Carbon Fiber_150-Stress-Stress1

Vonmises stress

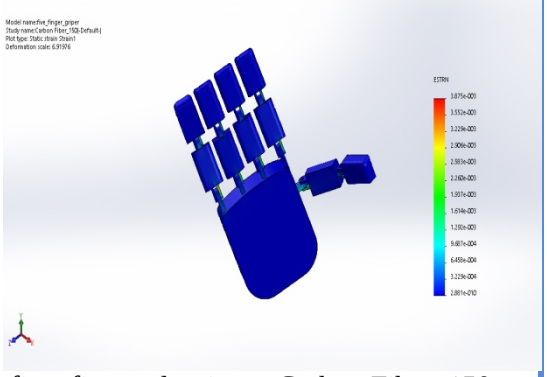
Maximum vonmises stress is obtained by applying 150 kgf with the value of 1390.13N/mm^2.

Resultant displacement

Maximum resultant displacement is obtained by applying 150 kgf with the value of 3.42769mm.

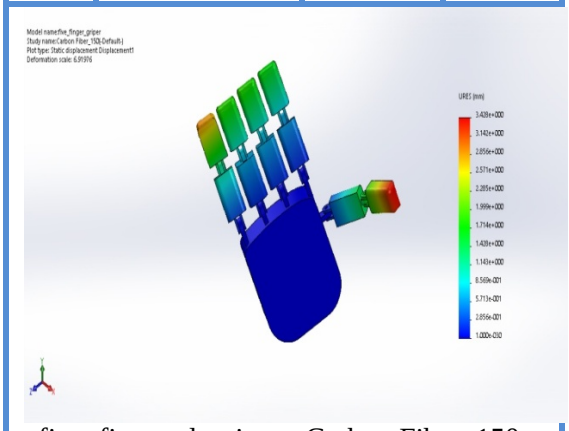
Name	Type	Min	Max
Strain 1	ESTRN: Equivalent Strain	2.88139e-010 Element: 33137	0.00387469 Element: 8211

Name	Type	Min	Max



five_fingered_gripper-Carbon Fiber_150-Strain-Strain1

Name	Type	Min	Max
Displacement 1	URES: Resultant Displacement	0 mm Node: 36287	3.42769 mm Node: 30379



five_fingered_gripper-Carbon Fiber_150-Displacement-Displacement1

Equivalent Strain

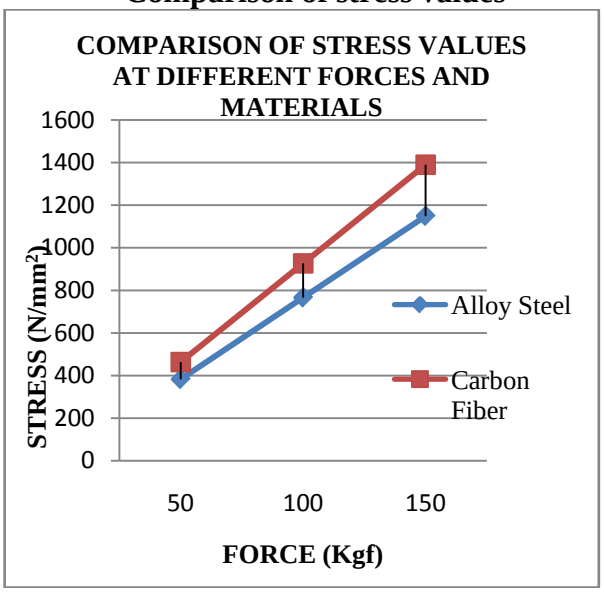
Maximumequivalent strain is obtained by applying 150 kgf with the value of 0.00387469.

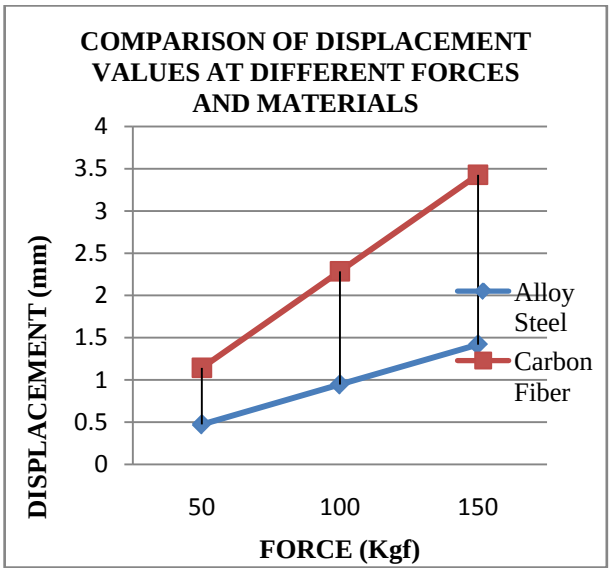
GRAPHS:

STATIC ANALYSIS:

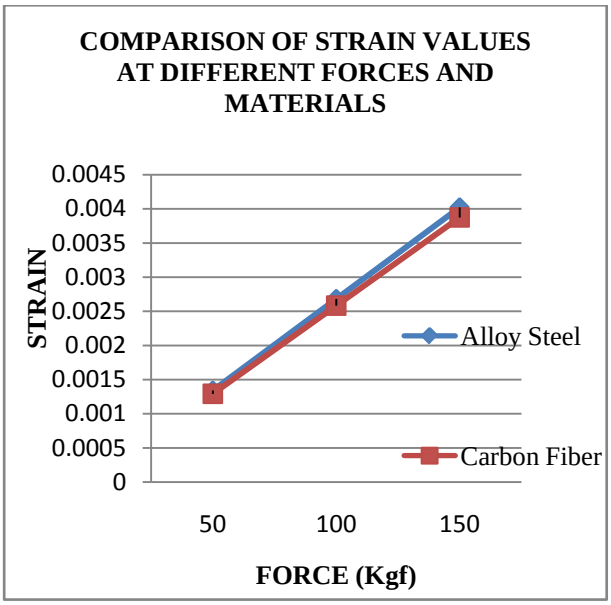
ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-4, ISSUE-2, 2017
DOI: 10.21276/ijcesr.2017.4.2.7

Comparison of stress values





Comparison of displacement values



Comparison of strain values

VI. CONCLUSION:

Motion analysis is performed on the gripper by applying angular displacement 45 degrees to the rotary motors determine angular velocity, angular momentum and motor torque.

By observing the results, the maximum angular velocity is obtained at 2.5sec with max value of 4deg/sec, the maximum angular momentum is obtained at 2.5sec with max value of 22953 N mm sec, and the max torque of the motor is obtained at 5 secs with value of 0.012 Nmm.

Static analysis is performed on the robot arm by applying forces of 50Kgf, 100Kgf and 150Kgf using two different materials Alloy Steel and Carbon Fiber. The advantage of using composite material Carbon Fiber is its high strength to weight ratio.

By observing the static analysis results, the stress values for steel material is less than its respective yield stress values when 50Kgf is applied and when 100Kgf and 150Kgf, using Steel is not advisable as it fails. But when Carbon Fiber is used, the stress values for all forces are less than its yield stress values. So using Carbon Fiber is better though the stresses when it is used are more than that of Steel. And also the weight of the robot arm will be less when Carbon Fiber is used since its density is less than that of Alloy Steel.

REFERENCES:

1. Robust Control for the Motion Five Fingered Robot Gripper, by W. Widhiada

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-4, ISSUE-2, 2017
DOI: 10.21276/ijcesr.2017.4.2.7

International Journal of Mechanical Engineering and Robotics Research, Vol.4, No. 3, pp. 226-232, July 2015.
2. By Krishnaraju A, Design of Three Fingered Robot-Gripper MechanismISSN 2321-5747, Volume-3, Issue-3, 2015.
3. By E. Simo-Serra, Kinematic Synthesis of Multi-fingered Robotic Hands for Finite and Infinitesimal Tasks. Lenarcic J. Husty M. (eds) Latest Advances in Robot Kinematics. Springer, Dordrecht.
4. Modal analysis of Pneumatic two Finger Robotic hand by Finite Element Analysis and Experimental Testing, by SafeenYassenQassab. Vol-13-I-03/130203-5656.
5. Kinematic Design and Compliant Grasp Analysis of a 5-Fingered Robotic Hand handling of objects with irregular shapes and that of flexible/soft objects by ordinary robot grippers is difficult, by Pramod Kumar Parida.
6. Design and Optimization of a Five-Finger Haptic Glove Mechanism, UshaSoni.
   Vol. 7 / 041008-7.
7. By NasimJafargholibeik, Design and Optimization of a Three-Fingered Robot Hand.
8. By Deepak Dhole, Comparison: 4 & 5 Finger Based Humanlike Robotic Hand. Paripex - indian journal of research 179-182.
9. Five-fingered Robot Hand using Ultrasonic Motors and Elastic Elements, by Ikuo.
10. Development Of A Two-Fingered And A Four-Fingered Robotic Gripper,byGovind.
    Issued on May2010, 166 pages.